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LABORATORY CENTRIFUGE HAVING A COOLING UNIT

The present invention relates to a laboratory centrifuge with an electric centrifuge motor.

In laboratory centrifuge of this type, it is common, as described in DE-41 36 514 C2, to form the centrifuge motor as a frequency-controlled induction motor that is fed by a frequency converter. This permits to achieve a required precision of adjustment of the motor rotational speed necessary for the centrifuge operation.

Also known are laboratory centrifuges having a cooling unit driven by an electric motor. In those, in accordance with the existing state of the art, the cooling motors have a simple design with a constant rotational speed, with the cooling power being controlled by switching the motor on and off.

DE-35 23 818 C3 discloses an air-conditioner the motor operation of which is frequency controlled.

The object of the present invention is to provide a laboratory centrifuge having a centrifuge motor with a rotational speed control and a cooling unit, and which centrifuge has a simple design and can be cost-effectively produced.

This object is achieved with features of claim 1.

According to the invention, not only the centrifuge motor but also the cooling motor have their rotational speeds controlled by controlling the frequency. This results in a possibility of better cooling control and permits to significantly simplified the construction. To this end, the already available frequency converter should be supplemented with a further inverted rectifier. Additional switching and control devices for the cooling motor are not necessary. A significant constructional simplification of the motor control is obtained which results in the costs reduction. In laboratory centrifuges, this is of a particular importance, as these can be successfully marketed essentially only as table apparatuses as small and economical as possible.

The control unit, which controls the frequency converter, can control both inverted rectifiers with the same frequency. The drawback of this consists in

that both the rotational speed and the cooling power are increased and decreased together. Therefore, advantageously, the features of claim 2 are provided. These features make it possible to separately control, as needed, the rotational speed and the cooling power.

With centrifuges, it is necessary to bring the rotor to a stop as soon as possible after a centrifuge process ends in order to be able to remove centrifuged samples in a short time. When the control frequency for the centrifuge inverter rectifier decreases, it supplies a high braking current in a d.c. source so that its voltage can reach an impermissible high value. According to the state of the art, the returned brake power is consumed, if required, in connectable brake resistances which increases the construction costs. Therefore, advantageously, the features of claim 3 are provided. In this way, during braking of the centrifuge motor, the returned brake power, at least partially, is converted into current consumed from the d.c. source by the cooling motor that functions as a brake resistance. Therefore, the number of additional brake resistances can be substantially reduced or be completely eliminated, whereby the costs of a centrifuge is further reduced. A complete separate control of the driving

powers of the centrifuge motor and the cooling motor can lead to a simultaneous full load in each of the two motors, and both the d.c. source and the mains power rectifier must be designed for this case. Therefore, advantageously, the features of claim 4 are provided. Such control connection of both motors ensures that during accelerations of the rotor when the centrifuge motor requires a lot of power, the cooling motor is driven with less power. As a result, the maximal power to-be-fed from the d.c. source is reduced, so that the components can be reduced, which again can reduce the costs of the centrifuge.

Advantageously, the features of claim 5 are provided. In this way, it is insured that the cooling motor runs at a speed below the minimal rotational speed only for a short time. This is an advantage when conventional cooling units with a compressor are used which for lubrication reasons, should operate above a minimal rotational speed.

The drawing shows, by way of example and schematically, a very simplified block-diagram of a centrifuge according to the present invention.

The centrifuge has a rotor 2 that has inwardly located seats (not shown) for a conventional centrifuge vessel. The rotor 2 is driven by a centrifuge motor 5 via a shaft 4. The motor 5 is formed as a three-phase induction motor.

The centrifuge motor 5 is fed from a centrifuge inverted rectifier 7 of a frequency converter 20 via three conductors 6. In the frequency converter 20, the centrifuge inverted rectifier 7 has its input conductors connected with plus and minus wires of a d.c. source 10.

The d.c. source 10 has, between the plus and minus wires, a conventional charging capacitor 11 and is fed from a mains power rectifier 12 that is connected by appropriate conductors with a.c. mains.

The centrifuge inverted rectifier 7 is connected to a frequency control 15 by control conductors. The frequency control feeds the frequency and voltage to the centrifuge inverter rectifier 7, with which the centrifuge motor 5 is controlled.

There is provided a cooling unit 17, in a very simplified representation of which is shown in the drawing cools the rotor 2 with a cooler 18 formed as a coiled

pipe cooler, and with a heat exchanger 19, likewise formed as a coiled pipe cooler, diverts heat outside of a non-shown housing. The cooling circuit is provided with a non-shown compressor driven by an electrical cooling motor 22 via a shaft 21.

The cooling motor 22 is likewise formed as an induction motor and is fed from a cooling inverted rectifier 24 via three conductors 23. This one, in the frequency converter, 20, has its input conductors connected to the plus and minus wires of the d.c. source 10, i.e., it is connected parallel to the centrifuge inverted rectifier 7. It is controlled via control lines by a frequency control 28 in a similar way as the centrifuge rectifier 7 is controlled.

In the centrifuge discussed above, the cooling power of the cooling unit 17 and the rotational speed of the rotor 2 may be adjusted completely separately in accordance with corresponding preselection. To this end, a control unit 30 is used which is connected with frequency controls 15 and 28 by corresponding data lines for inputting therein predetermined rotational speeds.

The control unit 30 can reduce the power for the cooling motor 22 by reducing the control frequency or completely shut out the motor 22, in particular during full load of the centrifuge motor 5 when the rotor 2 is accelerated. Thereby, overloading of the d.c. source 10 is prevented, and it can, e.g., have smaller charging capacitor 10 and mains power rectifier 12, and reduced dimensions and manufacturing costs.

The control unit 30 can be so formed that upon turning the centrifuge on, first, the cooling unit 17 remains turned off until the rotational speed of the rotor 2 reaches the region of its predetermined rotational speed. At this point, the power consumption of the centrifuge motor 5 is reduced, and the power of the cooling motor 22 can be increased, and can subsequently be again reduced when the desired temperature is reached, via temperature sensors (not shown) connected to the control unit 30.

After the centrifuge process has ended, a rapid braking of the rotor 2 is desired in order to be able to quickly unload the rotor. To this end, the control unit 30 is so formed that for braking the centrifuge, the frequency of the centrifuge inverted rectifier 7 is reduced. This leads to feeding the brake current back to

the d.c. source 10. With strong braking, the d.c. source 10 can be overloaded due to voltage increase.

In order to avoid use of conventional brake resistances, the control unit ensures that during braking of the centrifuge motor 5, the cooling inverted rectifier 24 is controlled with a predetermined frequency, so that the cooling motor 22 consumes current from the d.c. source 10. The cooling motor 22 functions as a brake resistance. Thus, the additional brake resistance can be dispensed with.

The control unit 30 is additionally so formed that the cooling inverted rectifier 24 can be operated only above a minimal frequency corresponding to a minimal rotational speed of the cooling motor 22. In this way, a cooling compressor (not shown), which is provided in the cooling unit 17, operates only above a certain minimal rotational speed, so that the problems of lubrication, which are associated with small rotational speeds, are avoided.